19-0272; Rev 3; 11/04

8-Channel/Dual 4-Channel, Low-Leakage, CMOS Analog Multiplexers

General Description

The MAX338/MAX339 are monolithic, CMOS analog multiplexers (muxes). The 8-channel MAX338 is designed to connect one of eight inputs to a common output by control of a 3-bit binary address. The dual, 4-channel MAX339 is designed to connect one of four inputs to a common output by control of a 2-bit binary address. Both devices can be used as either a mux or a demux. On-resistance is 400Ω max, and the devices conduct current equally well in both directions.

These muxes feature extremely low off leakages (less than 20pA at +25°C), and extremely low on-channel leakages (less than 50pA at +25°C). The new design offers guaranteed low charge injection (1.5pC typ) and electrostatic discharge (ESD) protection greater than 2000V, per method 3015.7. These improved muxes are pin-compatible upgrades for the industry-standard DG508A and DG509A. For similar Maxim devices with lower leakage and charge injection but higher on-resistance, see the MAX328 and MAX329.

The MAX338/MAX339 operate from a single +4.5V to +30V supply or from dual supplies of ±4.5V to ±20V. All control inputs (whether address or enable) are TTL compatible (+0.8V to +2.4V) over the full specified temperature range and over the ±4.5V to ±18V supply range. These parts are fabricated with Maxim's 44V silicon-gate process.

Applications

Data-Acquisition Systems	Sample-and-Hold Circuits
Test Equipment	Heads-Up Displays
Military Radios	Communications Systems
Guidance and Control Systems	PBX, PABX

Features

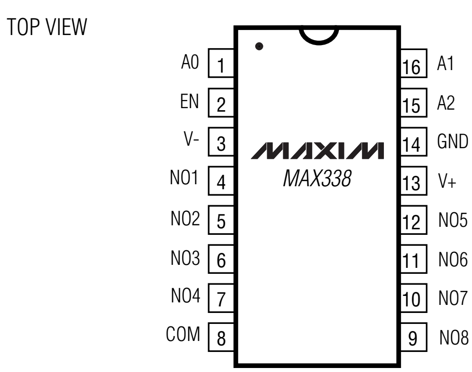
- **On-Resistance, <400Ω max**
- **Transition Time, <500ns**
- **On-Resistance Match, <10Ω**
- **NO-Off Leakage Current, <20pA at +25°C**
- **1.5pC Charge Injection**
- **Single-Supply Operation (+4.5V to +30V)**
  Bipolar-Supply Operation (±4.5V to ±20V)
- **Plug-In Upgrade for Industry-Standard DG508A/DG509A**
- **Rail-to-Rail Signal Handling**
- **TTL/CMOS-Logic Compatible**
- **ESD Protection >2000V, per Method 3015.7**

Ordering Information

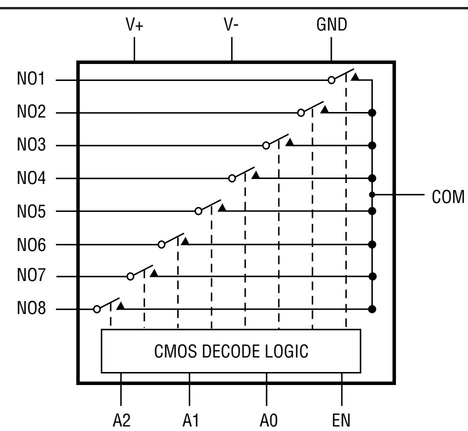
PART	TEMP RANGE	PIN-PACKAGE
MAX338CPE	0°C to +70°C	16 Plastic DIP
MAX338CSE	0°C to +70°C	16 Narrow SO
MAX338C/D	0°C to +70°C	Dice*
MAX338ETE	-40°C to +85°C	16 Thin QFN (5mm x 5mm)
MAX338EPE	-40°C to +85°C	16 Plastic DIP
MAX338ESE	-40°C to +85°C	16 Narrow SO
MAX338EJE	-40°C to +85°C	16 CERDIP
MAX338MJE	-55°C to +125°C	16 CERDIP**

Ordering Information continued at end of data sheet.
**Contact factory for dice specifications.*
***Contact factory for availability.*

Pin Configurations/Functional Diagrams/Truth Tables



DIP/SO



MAX338 8-CHANNEL SINGLE-ENDED MULTIPLEXER

Pin Configurations/Functional Diagrams/Truth Tables continued at end of data sheet.

ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V-
- V+ ....-0.3V, 44V
- GND ....-0.3V, 25V

Digital Inputs, NO, COM (Note 1)...........(V- - 2V) to (V+ + 2V) or 30mA (whichever occurs first)
Continuous Current (any terminal).....................................30mA
Peak Current, NO or COM
- (pulsed at 1ms, 10% duty cycle max) 100mA

Continuous Power Dissipation (TA = +70°C)
- Plastic DIP (derate 10.53mW/°C above +70°C) 842mW
- Narrow SO (derate 8.70mW/°C above +70°C) 696mW
- 16-Pin TQFN (derate 21.3mW/°C above +70°C) 1702mW
- CERDIP (derate 10.00mW/°C above +70°C)...............800mW

Operating Temperature Ranges
- MAX33_C__ ....0°C to +70°C
- MAX33_E__..-40°C to +85°C
- MAX33_MJE ....-55°C to +125°C

Storage Temperature Range ....-65°C to +150°C
Lead Temperature (soldering, 10sec) ....+300°C

Note 1: Signals on NO, COM, EN, A0, A1, or A2 exceeding V+ or V- are clamped by internal diodes. Limit forward current to maximum current ratings.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—Dual Supplies

(V+ = +15V, V- = -15V, GND = 0V, V_{AH} = +2.4V, V_{AL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS				MIN	TYP (Note 2)	MAX	UNITS
SWITCH									
Analog Signal Range	V_{NO}, V_{COM}	(Note 3)				-15		15	V
On-Resistance	R_{ON}	I_{NO} = 0.2mA, V_{COM} = ±10V		T_A = +25°C			220	400	Ω
				T_A = T_{MIN} to T_{MAX}				500	
On-Resistance Matching Between Channels	ΔR_{ON}	I_{NO} = 0.2mA, V_{COM} = ±10V (Note 4)		T_A = +25°C			4	10	Ω
				T_A = T_{MIN} to T_{MAX}				15	
NO-Off Leakage Current (Note 5)	$I_{NO(OFF)}$	V_{COM} = ∓10V, V_{NO} = ±10V, V_{EN} = 0V		T_A = +25°C		-0.02	0.001	0.02	nA
				T_A = T_{MIN} to T_{MAX}	C, E	-1.25		1.25	
					M	-20		20	
COM-Off Leakage Current (Note 5)	$I_{COM(OFF)}$	V_{NO} = ±10V, V_{COM} = ∓10V, V_{EN} = 0V	MAX338	T_A = +25°C		-0.05	0.005	0.05	nA
				T_A = T_{MIN} to T_{MAX}	C, E	-3.25		3.25	
					M	-40		40	
		V_{NO} = ∓10V, V_{COM} = ±10V, V_{EN} = 0V	MAX339	T_A = +25°C		-0.05	0.005	0.05	
				T_A = T_{MIN} to T_{MAX}	C, E	-1.65		1.65	
					M	-20		20	
COM-On Leakage Current (Note 5)	$I_{COM(ON)}$	V_{COM} = ±10V, V_{NO} = ±10V, sequence each switch on	MAX338	T_A = +25°C		-0.05	0.006	0.05	nA
				T_A = T_{MIN} to T_{MAX}	C, E	-3.25		3.25	
					M	-40		40	
			MAX339	T_A = +25°C		-0.05	0.008	0.05	
				T_A = T_{MIN} to T_{MAX}	C, E	-1.65		1.65	
					M	-20		20	

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

($V+ = +15V$, $V- = -15V$, GND = 0V, $V_{AH} = +2.4V$, $V_{AL} = +0.8V$, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS			MIN	TYP (Note 2)	MAX	UNITS
INPUT								
Input Current with Input Voltage High	I_{AH}	V_A = 2.4V or 15V			-1.0	0.001	1.0	µA
Input Current with Input Voltage Low	I_{AL}	V_{EN} = 0V or 2.4V, V_A = 0V			-1.0		1.0	µA
SUPPLY								
Power-Supply Range					±4.5		±20	V
Positive Supply Current	I+	$V_{EN} = V_A$ = 0V		T_A = +25°C		50	100	µA
				$T_A = T_{MIN}$ to T_{MAX}			150	
		V_{EN} = 2.4V, $V_{A(ALL)}$ = 2.4V		T_A = +25°C		290	500	µA
				$T_A = T_{MIN}$ to T_{MAX}			600	
Negative Supply Current	I-	V_{EN} = 0V or 2.4V, $V_{A(ALL)}$ = 0V, 2.4V or 5V		T_A = +25°C	-1		1	µA
				$T_A = T_{MIN}$ to T_{MAX}	-10		10	
DYNAMIC								
Transistion Time	t_{TRANS}	Figure 2		T_A = +25°C		200	500	ns
Break-Before-Make Interval	t_{OPEN}	Figure 4		T_A = +25°C	10	140		ns
Enable Turn-On Time	$t_{ON(EN)}$	Figure 3		T_A = +25°C		160	500	ns
				$T_A = T_{MIN}$ to T_{MAX}			750	
Enable Turn-Off Time	$t_{OFF(EN)}$	Figure 3		T_A = +25°C		100	500	ns
				$T_A = T_{MIN}$ to T_{MAX}			750	
Charge Injection (Note 3)	Q	C_L = 100pF, V_{NO} = 0V, R_S = 0Ω, Figure 6		T_A = +25°C		1.5	5	pC
Off Isolation (Note 6)	V_{ISO}	V_{EN} = 0V, R_L = 1kΩ, f = 100kHz		T_A = +25°C		-75		dB
Crosstalk Between Channels	V_{CT}	V_{EN} = 2.4V, f = 100kHz, $V_{GEN} = 1V_{P-P}$, R_L = 1kΩ, Figure 7		T_A = +25°C		-92		dB
Logic Input Capacitance	C_{IN}	f = 1MHz		T_A = +25°C		2		pF
NO-Off Capacitance	$C_{NO(OFF)}$	f = 1MHz, $V_{EN} = V_{NO}$ = 0V, Figure 8		T_A = +25°C		3		pF
COM-Off Capacitance	$C_{COM(OFF)}$	f = 1MHz, V_{EN} = 0.8V, V_{COM} = 0V, Figure 8	MAX338	T_A = +25°C		11		pF
			MAX339			6		
COM-On Capacitance	$C_{COM(ON)}$	f = 1MHz, V_{EN} = 2.4V, V_{COM} = 0V, Figure 8	MAX338	T_A = +25°C		16		pF
			MAX339			9		

8-Channel/Dual 4-Channel, Low-Leakage, CMOS Analog Multiplexers

ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = +12V, V- = 0V, GND = 0V, V_{AH} = +2.4V, V_{AL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
SWITCH							
Analog Signal Range	V_{NO}, V_{COM}	(Note 3)		0		12	V
On-Resistance	R_{ON}	I_{NO} = 0.2mA, V_{COM} = 3V or 10V	T_A = +25°C		460	650	Ω
DYNAMIC							
Transition Time (Note 3)	t_{TRANS}	V_{NO1} = 8V, V_{NO8} = 0V, V_{IN} = 2.4V, Figure 1	T_A = +25°C		210	500	ns
Enable Turn-On Time (Note 3)	$t_{ON(EN)}$	V_{INH} = 2.4V, V_{INL} = 0V, V_{NO1} = 5V, Figure 3	T_A = +25°C		280	500	ns
Enable Turn-Off Time (Note 3)	$t_{OFF(EN)}$	V_{INH} = 2.4V, V_{INL} = 0V, V_{NO1} = 5V, Figure 3	T_A = +25°C		110	500	ns
Charge Injection (Note 3)	Q	C_L = 100pF, V_{NO} = 0V, R_S = 0Ω	T_A = +25°C		1.8	5	pC

Note 2: The algebraic convention where the most negative value is a minimum and the most positive value a maximum is used in this data sheet.

Note 3: Guaranteed by design.

Note 4: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.

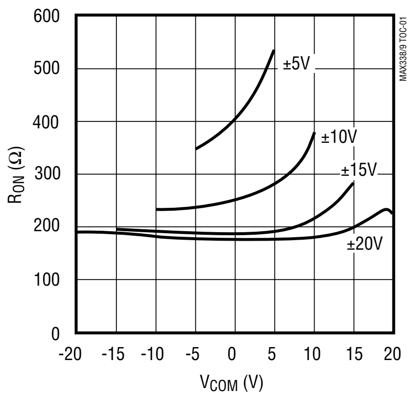
Note 5: Leakage parameters are 100% tested at the maximum rated hot temperature and guaranteed by correlation at +25°C.

Note 6: Worst-case isolation is on channel 4 because of its proximity to the drain pin. Off isolation = 20log V_{COM}/V_{NO}, where V_{COM} = output and V_{NO} = input to off switch.

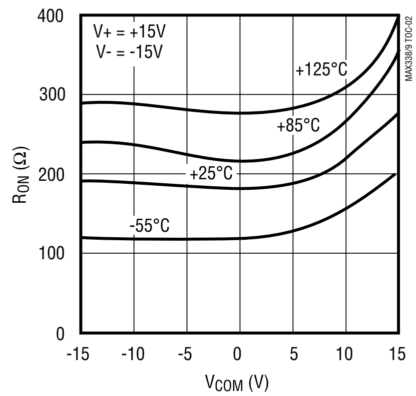
Typical Operating Characteristics

(T_A = +25°C, unless otherwise noted.)

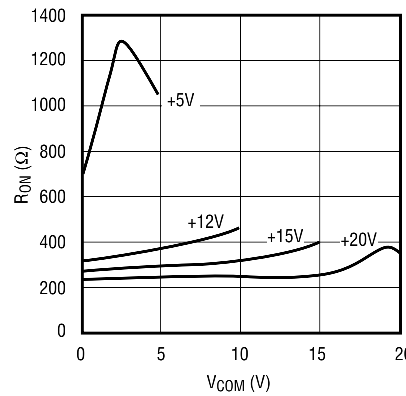
ON-RESISTANCE vs. VCOM (DUAL SUPPLIES)



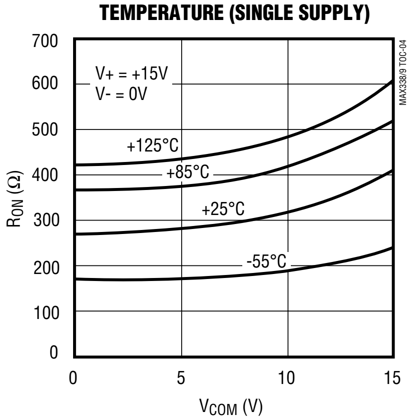
ON-RESISTANCE vs. VCOM OVER TEMPERATURE (DUAL SUPPLIES)



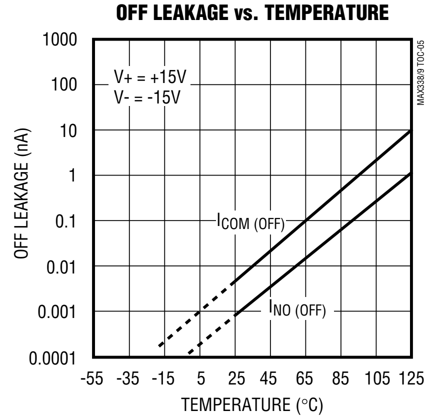
ON-RESISTANCE vs. VCOM (SINGLE SUPPLY)



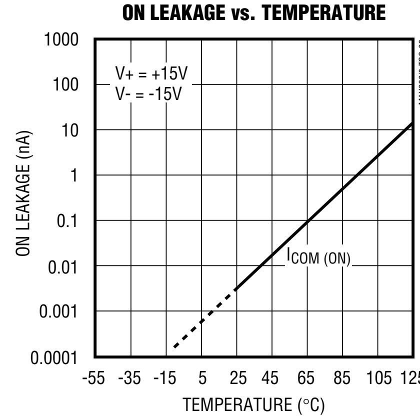
ON-RESISTANCE vs. VCOM OVER TEMPERATURE (SINGLE SUPPLY)



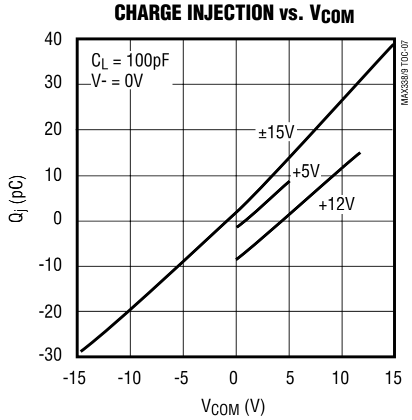
OFF LEAKAGE vs. TEMPERATURE



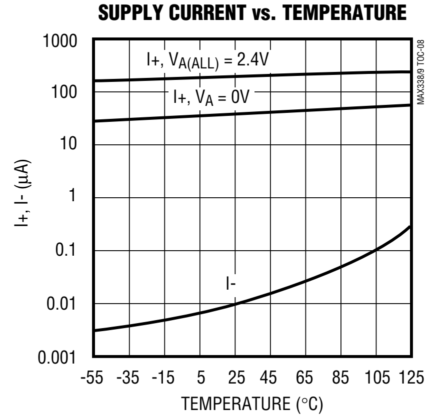
ON LEAKAGE vs. TEMPERATURE



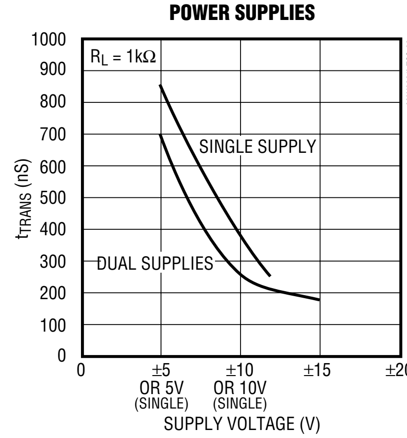
CHARGE INJECTION vs. VCOM



SUPPLY CURRENT vs. TEMPERATURE



TRANSITION TIME vs. POWER SUPPLIES



8-Channel/Dual 4-Channel, Low-Leakage, CMOS Analog Multiplexers

Pin Description

PIN				NAME	FUNCTION
MAX338		MAX339			
DIP/SO	THIN QFN	DIP/SO	THIN QFN		
1, 15, 16,	15, 14, 13	—	—	A0, A2, A1	Address Inputs
—	—	1, 16	15, 14	A0, A1	Address Inputs
2	16	2	16	EN	Enable
3	1	3	1	V-	Negative-Supply Voltage Input
4–7	2–5	—	—	NO1–NO14	Analog Inputs—Bidirectional
—	—	4–7	2–5	NO1A–NO4A	Analog Inputs—Bidirectional
8	6	—	—	COM	Analog Output—Bidirectional
—	—	8, 9	6, 7	COMA, COMB	Analog Outputs—Bidirectional
9–12	7–10	—	—	NO8–NO5	Analog Inputs—Bidirectional
—	—	10–3	8–11	NO4B–NO1B	Analog Inputs—Bidirectional
13	11	14	12	V+	Positive-Supply Voltage Input
14	12	15	13	GND	Ground
—	EP	—	EP	Exposed Pad	Exposed Pad. Connect to V+.

Applications Information

Operation with Supply Voltages Other than 15V

Using supply voltages less than ±15V will reduce the analog signal range. The MAX338/MAX339 switches operate with ±4.5V to ±20V bipolar supplies or with a +4.5V to +30V single supply. Connect V- to GND when operating with a single supply. Both device types can also operate with unbalanced supplies such as +24V and -5V. The *Typical Operating Characteristics* graphs show typical on-resistance with 20V, 15V, 10V, and 5V supplies. (Switching times increase by a factor of two or more for operation at 5V.)

Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings, because stresses beyond the listed ratings may cause permanent damage to the devices. Always sequence V+ on first, then V-, followed by the logic inputs NO and COM. If power-supply sequencing is not possible, add two small signal diodes in series with supply pins for overvoltage protection (Figure 1). Adding diodes reduces the analog signal range to 1V below V+ and 1V above V-, but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed 44V.

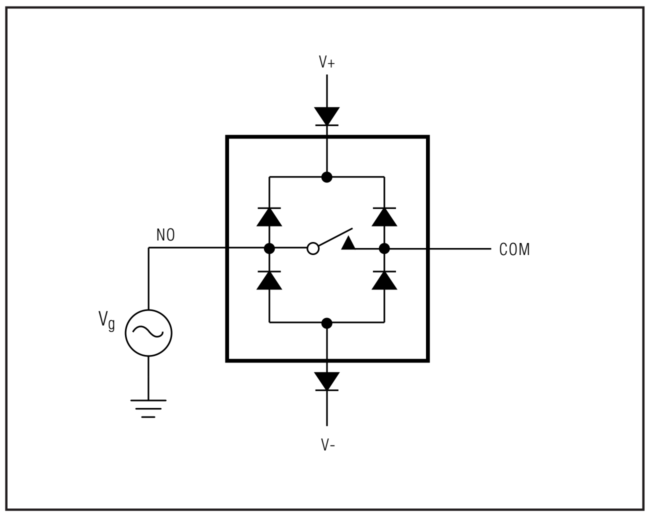


Figure 1. Overvoltage Protection Using External Blocking Diodes

Test Circuits/Timing Diagrams

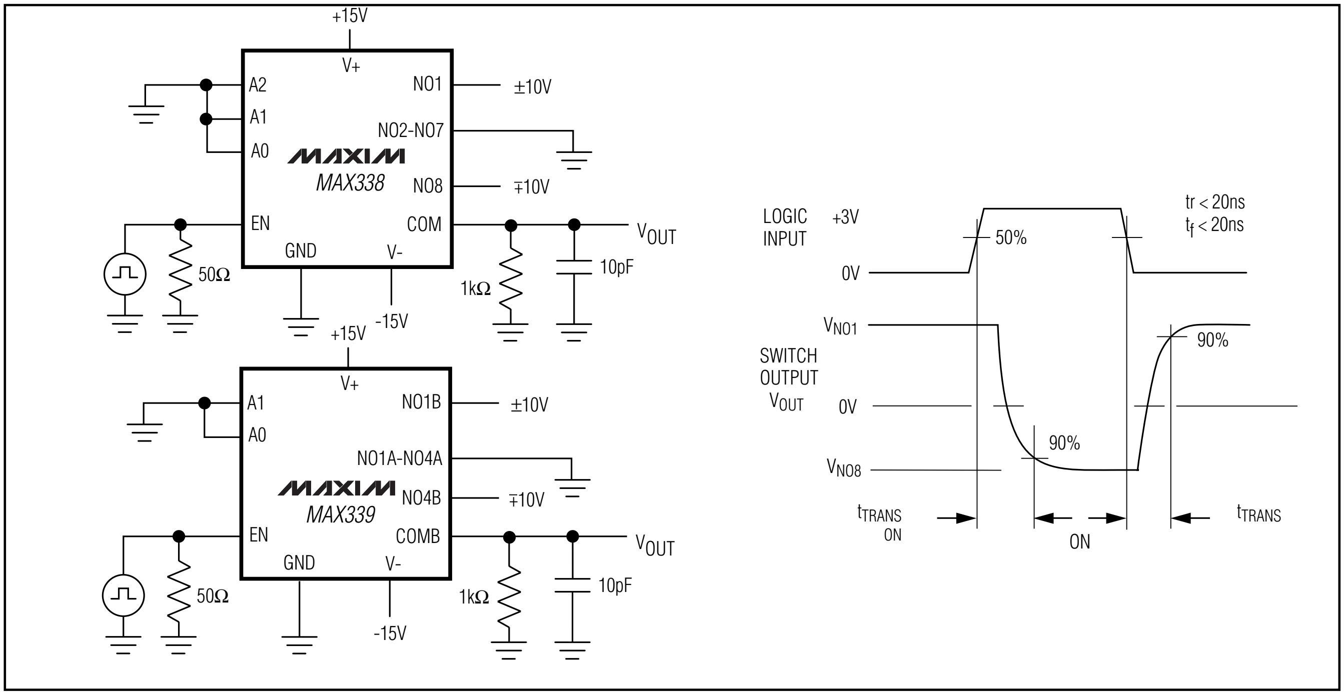


Figure 2. Transition Time

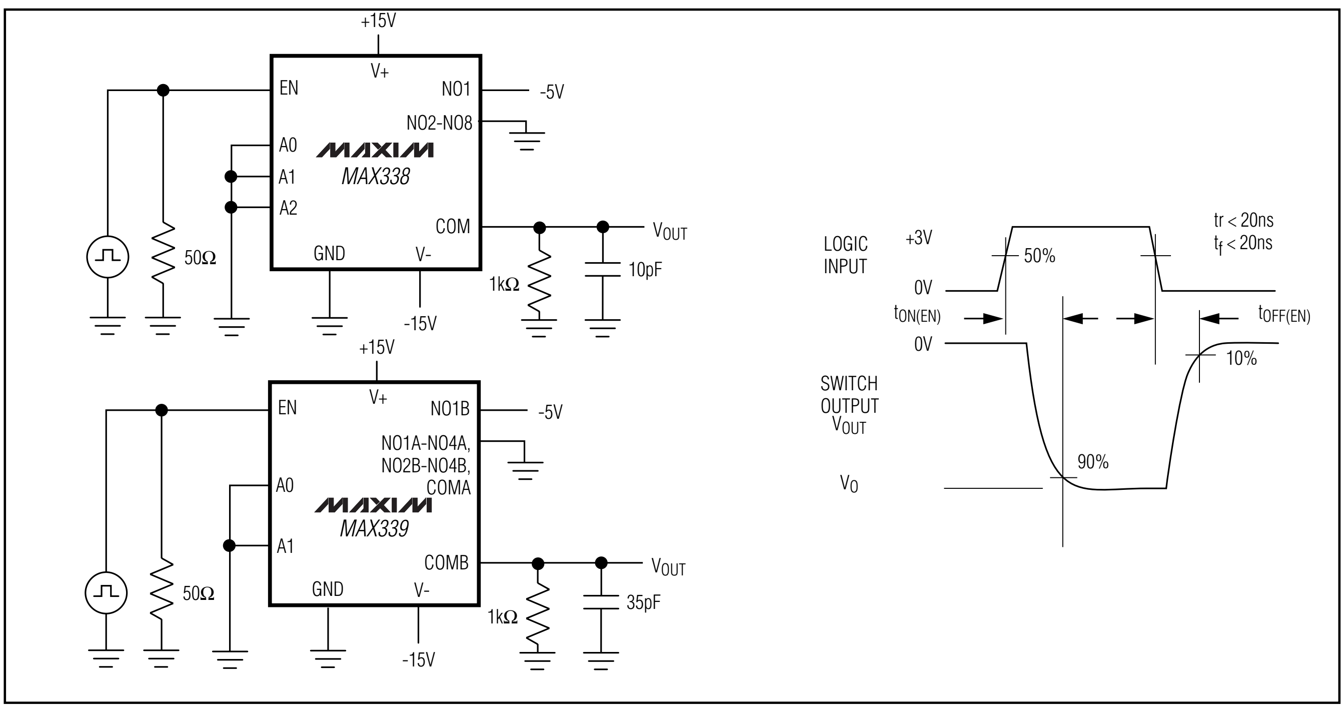


Figure 3. Enable Switching Time

8-Channel/Dual 4-Channel, Low-Leakage, CMOS Analog Multiplexers

Test Circuits/Timing Diagrams (continued)

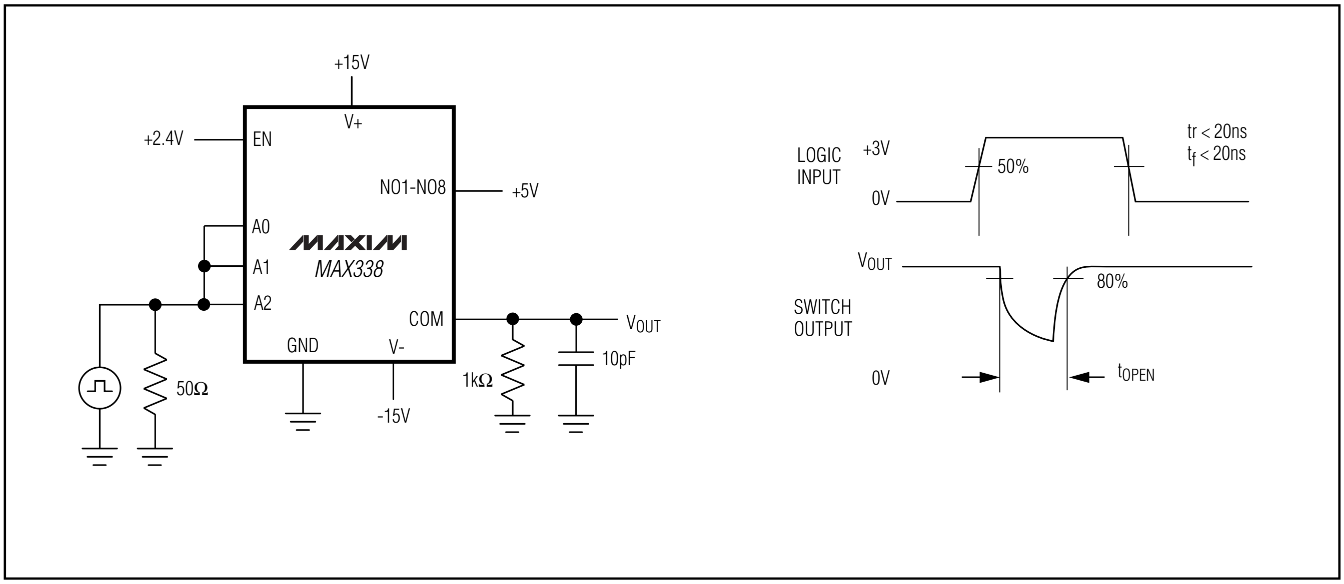


Figure 4. Break-Before-Make Interval

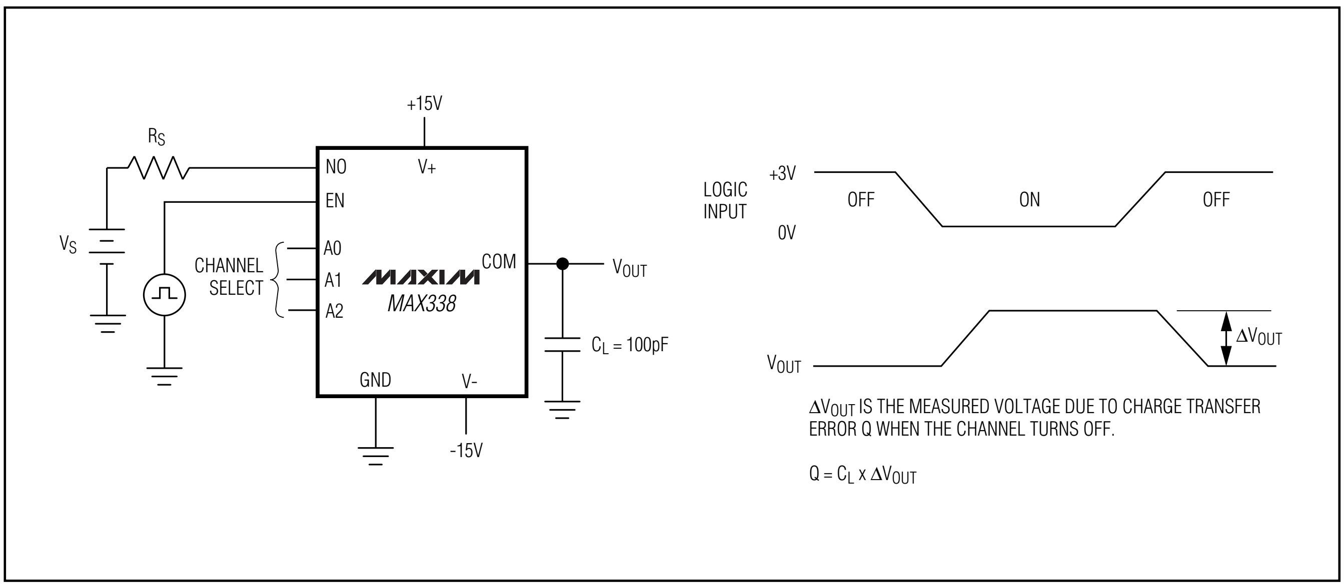


Figure 5. Charge Injection

Test Circuits/Timing Diagrams (continued)

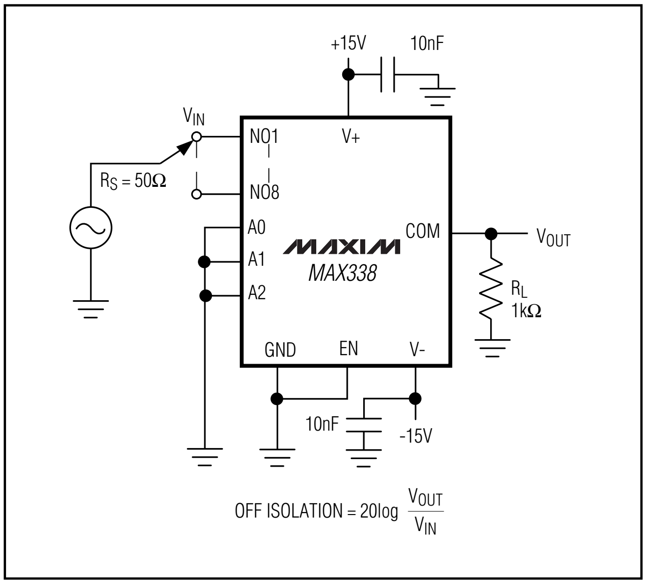


Figure 6. Off-Isolation

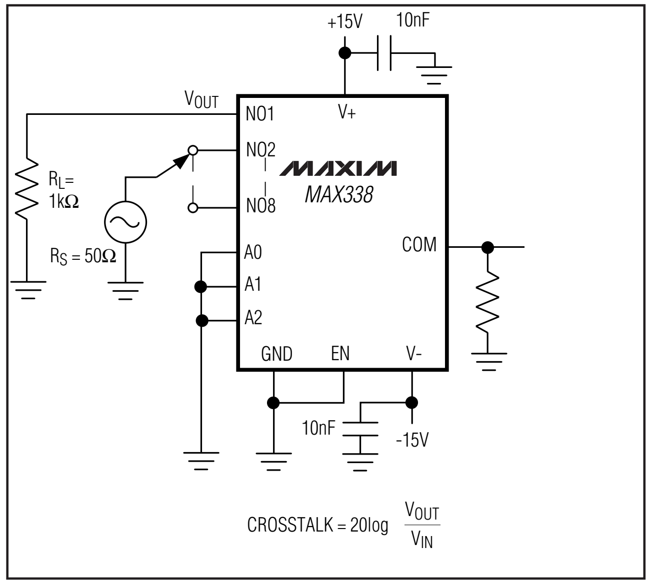


Figure 7. Crosstalk

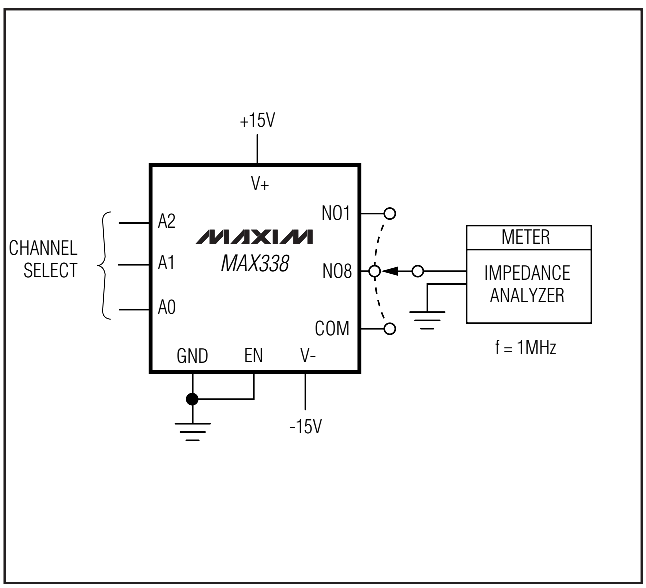
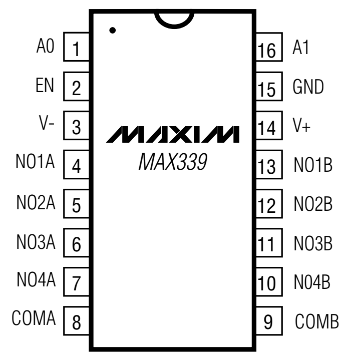


Figure 8. NO/COM Capacitance

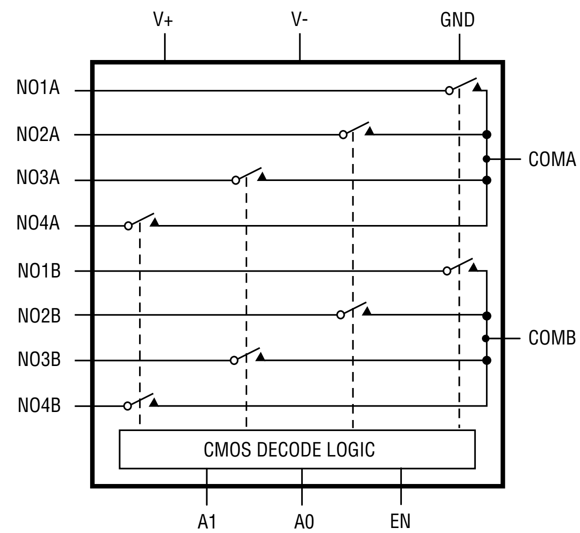
8-Channel/Dual 4-Channel, Low-Leakage, CMOS Analog Multiplexers

Pin Configurations/Functional Diagrams/Truth Tables (continued)

TOP VIEW



DIP/SO



MAX339 DUAL 4-CHANNEL MULTIPLEXER

A2	A1	A0	EN	ON SWITCH
X	X	X	0	None
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

MAX338

LOGIC "0" $V_{AL} \leq 0.8V$, LOGIC "1" $V_{AH} \geq 2.4V$

A1	A0	EN	ON SWITCH
X	X	0	None
0	0	1	1
0	1	1	2
1	0	1	3
1	1	1	4

MAX339

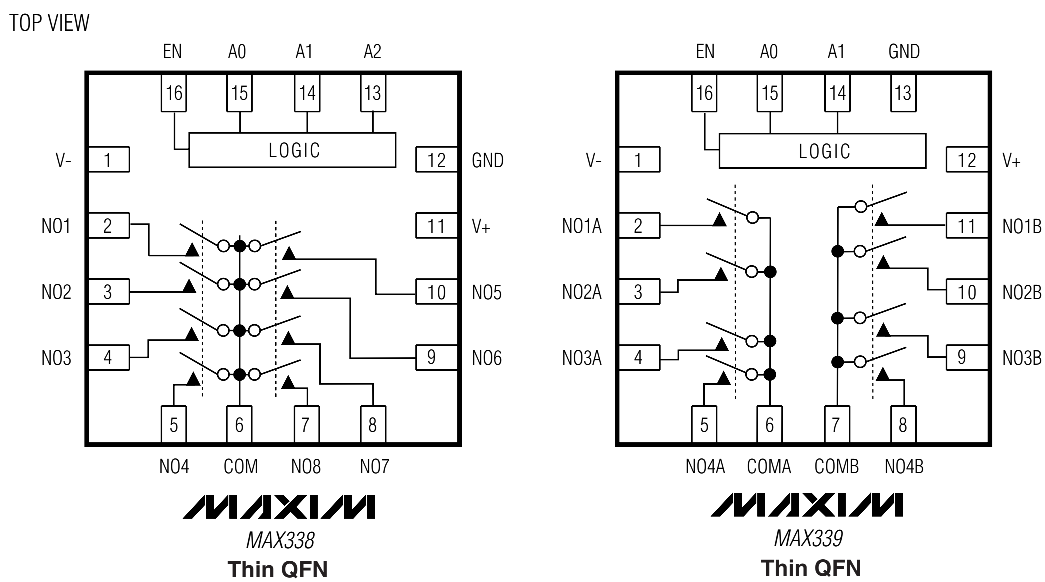
LOGIC "0" $V_{AL} \leq 0.8V$, LOGIC "1" $V_{AH} \geq 2.4V$

Ordering Information (continued)

PART	TEMP RANGE	PIN-PACKAGE
MAX339CPE	0°C to +70°C	16 Plastic DIP
MAX339CSE	0°C to +70°C	16 Narrow SO
MAX339C/D	0°C to +70°C	Dice*
MAX339ETE	-40°C to +85°C	16 Thin QFN (5mm x 5mm)
MAX339EPE	-40°C to +85°C	16 Plastic DIP
MAX339ESE	-40°C to +85°C	16 Narrow SO
MAX339EJE	-40°C to +85°C	16 CERDIP
MAX339MJE	-55°C to +125°C	16 CERDIP**

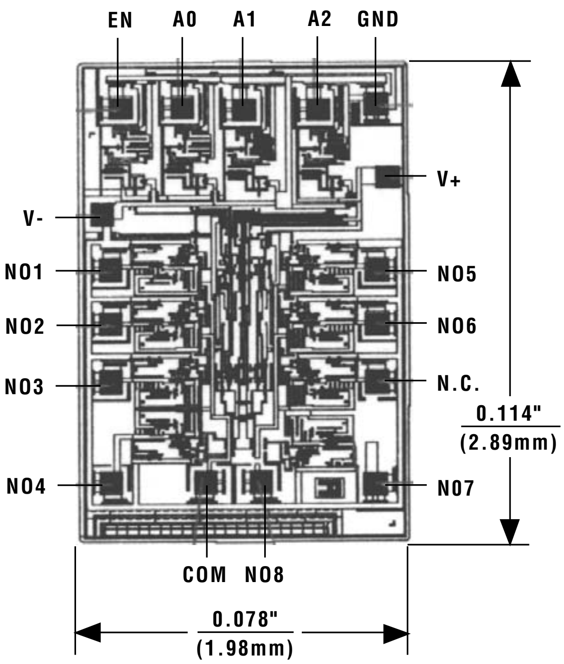
*Contact factory for dice specifications.
**Contact factory for availability.

Pin Configurations/Functional Diagrams/Truth Tables (continued)

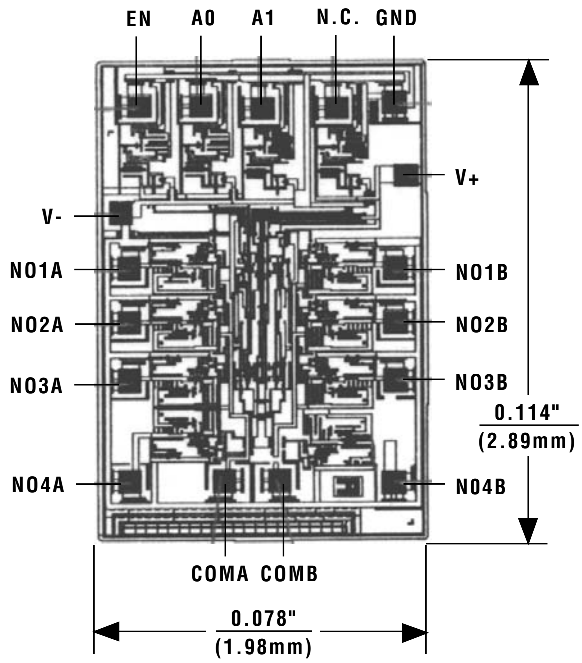


Chip Topographies

MAX338



MAX339



N.C. = NO INTERNAL CONNECTION

MAX338:

TRANSISTOR COUNT: 224

SUBSTRATE IS INTERNALLY CONNECTED TO V+

Note: On Thin QFN packages connect exposed pad to V+.

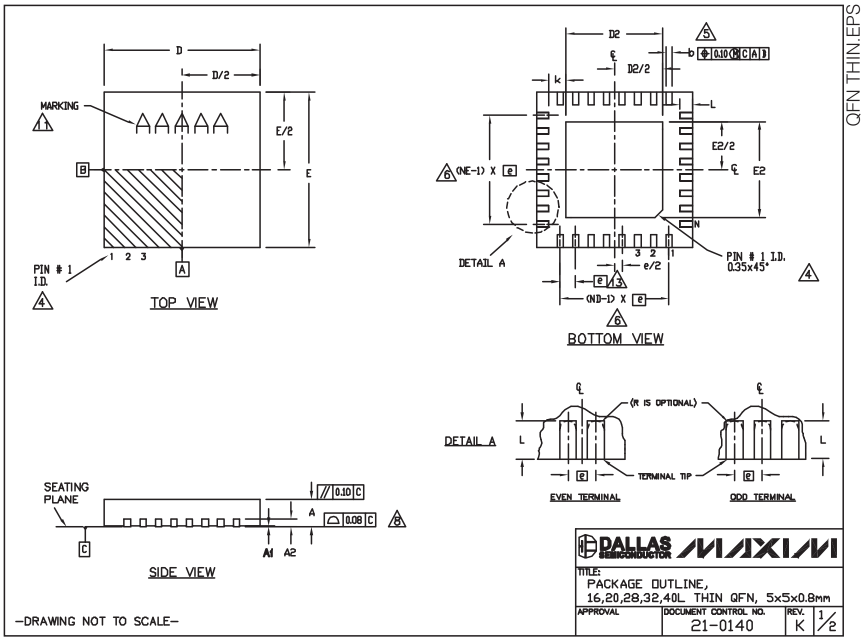
MAX339:

TRANSISTOR COUNT: 224

SUBSTRATE IS INTERNALLY CONNECTED TO V+

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)



COMMON DIMENSIONS

PKG.	16L 5x5			20L 5x5			28L 5x5			32L 5x5			40L 5x5		
SYMBOL	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80	0.70	0.75	0.80
A1	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05
A2	0.20 REF.			0.20 REF.			0.20 REF.			0.20 REF.			0.20 REF.		
b	0.25	0.30	0.35	0.25	0.30	0.35	0.20	0.25	0.30	0.20	0.25	0.30	0.15	0.20	0.25
D	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10
E	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10
e	0.80 BSC.			0.65 BSC.			0.50 BSC.			0.50 BSC.			0.40 BSC.		
k	0.25	-	-	0.25	-	-	0.25	-	-	0.25	-	-	0.25	-	-
L	0.30	0.40	0.50	0.45	0.55	0.65	0.45	0.55	0.65	0.30	0.40	0.50	0.30	0.40	0.50
N	16			20			28			32			40		
ND	4			5			7			8			10		
NE	4			5			7			8			10		
JEDEC	WHHB			WHHC			WHHD-1			WHHD-2			-----		

EXPOSED PAD VARIATIONS

PKG. CODES	D2			E2		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
T1655-2	3.00	3.10	3.20	3.00	3.10	3.20
T1655-3	3.00	3.10	3.20	3.00	3.10	3.20
T1655N-1	3.00	3.10	3.20	3.00	3.10	3.20
T2055-3	3.00	3.10	3.20	3.00	3.10	3.20
T2055-4	3.00	3.10	3.20	3.00	3.10	3.20
T2055-5	3.15	3.25	3.35	3.15	3.25	3.35
T2055M-5	3.15	3.25	3.35	3.15	3.25	3.35
T2855-3	3.15	3.25	3.35	3.15	3.25	3.35
T2855-4	2.60	2.70	2.80	2.60	2.70	2.80
T2855-5	2.60	2.70	2.80	2.60	2.70	2.80
T2855-6	3.15	3.25	3.35	3.15	3.25	3.35
T2855-7	2.60	2.70	2.80	2.60	2.70	2.80
T2855-8	3.15	3.25	3.35	3.15	3.25	3.35
T2855N-1	3.15	3.25	3.35	3.15	3.25	3.35
T3255-3	3.00	3.10	3.20	3.00	3.10	3.20
T3255-4	3.00	3.10	3.20	3.00	3.10	3.20
T3255M-4	3.00	3.10	3.20	3.00	3.10	3.20
T3255-5	3.00	3.10	3.20	3.00	3.10	3.20
T3255N-1	3.00	3.10	3.20	3.00	3.10	3.20
T4055-1	3.40	3.50	3.60	3.40	3.50	3.60
T4055-2	3.40	3.50	3.60	3.40	3.50	3.60

NOTES:

1. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
3. N IS THE TOTAL NUMBER OF TERMINALS.
4. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
5. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25 mm AND 0.30 mm FROM TERMINAL TIP.
6. ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
7. DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
8. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
9. DRAWING CONFORMS TO JEDEC MO220, EXCEPT EXPOSED PAD DIMENSION FOR T2855-3, T2855-6, T4055-1 AND T4055-2.
10. WARPAGE SHALL NOT EXCEED 0.10 mm.
11. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
12. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.
13. LEAD CENTERLINES TO BE AT TRUE POSITION AS DEFINED BY BASIC DIMENSION 'e', ±0.05.

-DRAWING NOT TO SCALE-

DALLAS SEMICONDUCTOR MAXIM

TITLE: PACKAGE OUTLINE, 16,20,28,32,40L THIN QFN, 5x5x0.8mm

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0140	K	1/2